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Noise Assessment and Error Analysis of GNSS Reflectometry Data for Water Surface Altimetry

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The field of GNSS reflectometry has been gaining a lot of popularity in recent years, mostly because of its potential to generate multiple types of measurements on a global scale with a high repeatability rate. However, the challenge is to operationalize a GNSS reflectometry system with accuracy compatible with other technologies, such as satellite altimetry.

Deimos Engenharia is currently leading the FP7 E-GEM project, which aims to evolve the current status of GNSS reflectometry in order to allow the implementation of operational applications (mainly in the domains of ocean altimetry and scatterometry). Within E-GEM Deimos is developing a ground instrument to collect reflectometry observables - namely, direct and reflected waveforms or autocorrelation functions that will be used to derive sea surface altimetry through the delay differences method.

This paper presents the work that has been done in order to assess the expected noise for the Galileo E1 signal for the direct and reflected waveforms, as well as their delay differences that are used to obtain the final altimetric result. Several methods were used to estimate the noise, including tracking methods, fits and maxima determination, and the comparison with Gaussian noise expectations is performed. The results obtained using different methods will be presented. The Water Surface Altimetry is also derived, based on the delay differences and satellite elevation, and compared with concurrent tide gauge data.

It can be concluded that without integration the noise level is of the order of 8 m, in good agreement with the expected values, taken into account that no filtering is applied. Moreover, some effects were detected and were not eliminated with delay differences, indicating that other error sources may be contributing to the noise (such as unwanted multipath). When the integration is performed the noise level is of the order of 50 cm, and for the delay differences the noise seems to approach a Gaussian behavior. When comparing altimetry data with traditional tide gauges, a bias was detected that should be eliminated through calibration or by using a non-biased estimator for peak determination for the reflected waveform.

Further work must be done in order to reach feasible accuracies for an operational instrument. With the development of new reflectometry instruments and the use of the Galileo E5 signal, the system accuracy can be definitely improved.